TITLE OF THE INVENTION

RECORDING APPARATUS FOR A HOLOGRAPHIC RECORDING MEDIUM

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is based upon and claims the benefit of priority from the prior Japanese Patent Application No. 2000-301069, filed September 29, 2000, the entire contents of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to an information recording medium for recording information in a three-dimensional photorecording medium, in particular, to a recording medium for recording information in a holographic recording memory.

2. Description of the Related Art

As a recording medium which is capable of recording a large amount of data which requires a large memory capacity such as an image of high density, a photorecording medium is known to be useful. Conventionally, as a photorecording medium, a photomagnetic recording medium and an optical phase change recording medium have been developed. However, there is still increasing demands for an optical recording medium having a capacity for recording a more increased density of information.

There has been proposed a three-dimensional

optical recording medium for realizing the recording of such an increased density of information. In this three-dimensional optical recording medium, a signal light beam bearing a plurality of information and a light beam called a reference light beam are simultaneously irradiated as a spatial distribution onto a specimen, thereby enabling the information to be stored as a hologram in the optical recording medium.

In the conventional optical phase change recording medium mentioned above, since the light beam is converged through an objective lens and the information is recorded bit by bit in the light beam spot, the recording capacity is restricted depending on the diameter of light beam. Whereas in the case of the holographic recording using a photochromic material or a photorefractive material, the signal light beam is caused to intersect with a reference light beam emitted coherent to the signal light beam, thereby enabling the information to be stored as a hologram in the recording medium. In this case, a light beam having a spatial distribution in intensity or in phase is employed as the signal light beam, enabling a difference in intensity or in phase at a specific region to be generated corresponding to information. Accordingly, a plurality of information extending two-dimensionally can be recorded as a hologram.

It is possible, according to this holographic

recording, to record different holograms at an overlapping region by altering the angle of the signal light beam or reference light beam, or by slightly changing the location to be irradiated with the light beam. As a result, this holographic recording is considered as capable of realizing an extremely large recording capacity which is incomparable to the conventional recording systems.

When it is desired to reproduce the information that has been recorded in the optical recording medium in the form of a hologram, a read-out light beam is impinged against the same region at the same angle as that of the reference light beam. As a result, according to the principle of a hologram, the signal light beam is reproduced, thereby enabling the intensity distribution of the signal light beam thus reproduced to be detected by a split detector such as a CCD.

However, it is required, on the occasion of reading the hologram, to impinge a read-out signal under quite the same conditions as the reference light beam employed in the recording of information. Therefore, it is required to employ a tracking and focusing system for irradiating a light beam from a recording/reading light source onto the same region on the recording medium. There are known the following two systems for realizing this object.

One of these systems is set forth in the publication; "Implementation of Holographic Optical Disc", G. Zhou; A. Pu; O. Ivanova; F. Mok, and D. Psaltis; Proceedings of the International Symposium on Optical Memory (pp. 14-15, 1998). This system is featured in that a signal for alignment is recorded outside the data region. Namely, it is designed such that the intensity of the alignment signal detected by a split detector as a readout light beam is irradiated is calculated at first, and based on this calculation, the timing of taking up a data is determined and at the same time, the tracking is performed. However, since the intensity of a light beam of a hologram thus reproduced becomes gradually weaker as it goes far away from the optical axis in general, it is impossible according to this system to increase the SN ratio.

The other system is featured in that an optical recording medium having a recessed/projected reflection surface is employed. Specifically, there are provided an address region and a data recording region, and a light beam is impinged against the address region, thereby enabling the tracking and focusing to be performed in the same manner as in the case where an ordinary optical disk such as CD (compact disk) or DVD (digital versatile disk) is employed. As for the method of alignment, it is explained in detail in the publication, "Optical Pick-up Head", Y. Hori; M. Kato;

Applied Physics Bulletin, Dec. 1999, pp. 1401-1406. However, in contrast with the DVD where the thickness of the recording layer is several nanometers, the thickness of the recording layer in the case of a hologram is as large as about 1 mm. Thus, there is a problem in the case of this hologram that, even if the hologram is recorded centering around the data region, the alignment light beam is diffracted by the hologram that has been recorded therein on an occasion of irradiating the alignment light beam onto the address region.

According to the method of alignment employed in the CD or DVD, the tracking signal and focusing signal are obtained based on the magnitude of broadening of the light beam reflected from the reflection surface of the optical recording medium. Therefore, once the alignment light beam is diffracted by the hologram, it becomes a noise. Accordingly, even if the diffraction efficiency is improved for the purpose of enhancing the SN ratio at the time of data readout, it will lead to an increase of diffraction on the occasion of alignment. As a result, the accuracy of alignment would be deteriorated, and hence the SN ratio cannot be increased at the time of reading the data.

BRIEF SUMMARY OF THE INVENTION

As explained above, since the thickness of the recording layer is several nanometers in the optical

phase change recording medium employed at present, the diffraction or scattering of light beams at the recording layer may be more or less disregarded irrespective of if the recording layer is in a crystal state or in an amorphous state. In the case of the recording medium which is designed to be employed in a holographic memory, since the thickness of the recording layer is as thick as 1 mm, once a hologram is recorded in the recording layer, not only the readout light beam but also the alignment light beam are diffracted at this recording layer. Since this phenomenon leads to the generation of noise for the alignment light beam, it is no longer possible to realize a tracking of high precision. Even if it is desired to improve the diffraction efficiency for the purpose of enhancing the SN ratio at the time of data readout, since the alignment light beam is diffracted correspondingly, the noise in the alignment signal would be further increased. As a result, it is impossible to enhance the SN ratio on the occasion of reading the data.

Therefore, an object of this invention is to provide an information recording medium which is capable of recording information in a three-dimensional optical recording medium constituted by a holographic recording medium which is designed to store the information in the form of a hologram, the information

recording medium being characterized in that the tracking and focusing of a recording light beam can be accurately achieved.

Namely, according to this invention, there is provided a recording apparatus for a holographic recording medium having an alignment mark and designed to irradiate a recording light beam onto a recording region of holographic recording medium to record information as a hologram, the recording apparatus comprising:

a recording laser irradiating the recording light beam for recording the hologram onto the holographic recording medium;

an alignment laser irradiating an alignment light beam onto the holographic recording medium, the alignment light beam being less absorbed than the recording light beam by the holographic information medium, and being reflected by the holographic recording medium;

a first lens converging the recording light beam irradiated from the recording laser and directing the converged recording light beam toward the holographic recording medium;

a second lens converging the alignment light beam irradiated from the alignment laser and directing the alignment light beam toward the holographic recording medium;